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LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

[Abstract]

PROBLEM TO BE SOLVED: To provide a new liquid crystal display device of high reliability having preferable alignment characteristics of the liquid crystal, which is manufactured by using a photosetting resin composition as a sealing material, taking little time for injection of the liquid crystal, suppressing misalignment of the two substrates or gap fluctuation to extremely small, without causing contamination of the liquid crystal or

intrusion of dust and without damaging alignment layers on the electrode substrates and a method of manufacturing the device.

SOLUTION: A photosetting sealing material is applied on at least one of two electrode substrates with alignment layers facing each other, and spacers are scattered on and fixed to one of the electrode substrates. Then, the liquid crystal in a required amount is dropped onto the electrode substrate where the sealing material is applied and the two electrode substrates are stacked one on another under vacuum. Then, the sealing material is irradiated with a light of ≥ 350 nm wavelength under normal pressure to stick together the substrates.

[Claims]

[Claim 1]

A liquid crystal display device, manufactured by applying a light curable sealing material on at least one surface of two facing electrode substrates each having an alignment film attached thereto, distributing and holding spacers on any one electrode substrate, adding a necessary amount of liquid crystals in droplets to the electrode substrate on which the sealing material is applied, laminating the two electrode substrates in a vacuum, and radiating light having a wavelength of 350 nm or more onto the sealing material under atmospheric pressure to bond the electrode substrates.

[Claim 2]

A method of manufacturing the liquid crystal display device of claim 1, comprising: applying a radical polymerizable type light curable resin composition having a viscosity at 25°C ranging from 40 to 100 Pa·s, serving as a sealing material, on an electrode substrate, and radiating light having a wavelength ranging from 350 to 780 nm from a light source onto the sealing material to cure the sealing material.

[Claim 3]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an acryl-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 4]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an acryl-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 5]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an ene/thiol-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 6]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an ene/thiol-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 7]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition and an ene/thiol-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 8]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition and an ene/thiol-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 9]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 10]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 11]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an ene/thiol-based light curable resin composition and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 12]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an ene/thiol-based light curable resin composition and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 13]

The method as set forth in claim 2, wherein the applying of the

radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition, an ene/thiol-based light curable resin composition, and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 14]

The method as set forth in claim 2, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using a mixture comprising an acryl-based light curable resin composition, an ene/thiol-based light curable resin composition, and an adhesion accelerator, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Claim 15]

The liquid crystal display device as set forth in claim 1, wherein each of the two facing electrode substrates, which has an alignment film attached thereto, further includes a thin film transistor and a color filter provided on one surface thereof, and a transparent conducting film provided on the other surface thereof.

[Claim 16]

A method of manufacturing the liquid crystal display device of claim 15, comprising applying a radical polymerizable type light curable resin composition having a viscosity at 25°C ranging from 40 to 100 Pa·s, serving as a sealing material, on an electrode substrate, and radiating light at a wavelength ranging from 350 to 780 nm from a light source onto the sealing material to cure the sealing material.

[Claim 17]

The method as set forth in claim 16, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an acryl based light curable resin composition, and the radiating of the light is performed by radiating

ultraviolet rays onto the sealing material to light cure the sealing material while the surface of the alignment film is shielded from light using a masking member.

[Claim 18]

The method as set forth in claim 16, wherein the applying of the radical polymerizable type light curable resin composition serving as a sealing material is performed by using an acryl-based light curable resin composition, and the radiating of the light is performed by radiating ultraviolet rays passed through a cut-off filter, to block light having wavelengths less than 350 nm, onto the sealing material to light cure the sealing material.

[Title of the invention]

LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

[Detailed Description of the Invention]

[Field of the Invention]

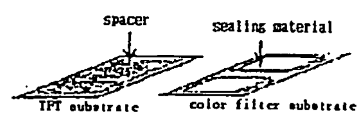
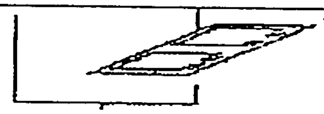
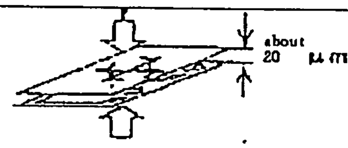
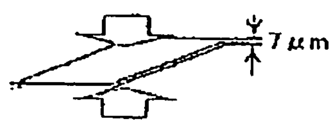
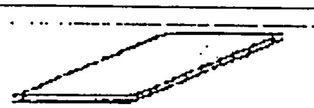
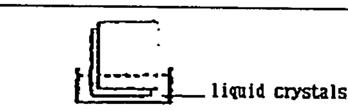
The present invention relates to a liquid crystal display (LCD) device for use in slim, lightweight, and low powered display technologies, and a method of manufacturing the same.

[Description of the Prior Art]

Recently, LCD devices have been variously applied to slim, lightweight, and low powered display technologies, and are expected to be increasingly used in the future.

The LCD device has been conventionally manufactured through processes using a heat curable type sealing material, shown in Table 1 below, which takes a long time period.

TABLE 1

Process		Heat Curable Type	Light Curable Type	
Distributing Spacers, Applying Sealing Material		-	-	-
Drying Solvent		10 min (120°C)		
Alignment		2 min (80°C)	5 min (RT/Radiating Light)	5 min (RT, Radiating Light In The Presence Of Liquid Crystals)
Controlling Gap		1.0 h (90-100°C)		
Heat-Curing Sealing Material		10 h (90-190°C)	-	-
Injecting Liquid Crystals		4 h (RT)		-
Closing Inlet		4 h (RT)		-

RT: 25°C

At present, attempts have been made to improve the conventional

process using a short time process involving a light curable type sealing material, as shown in Table 1. Particularly, as shown in right columns of Table 1, a closing process is expected to be performed for a short time period in the presence of liquid crystals using a light curable type sealing material.

Conventionally, methods of manufacturing an LCD device have been proposed as follows:

(1) As shown in FIGS. 1a and 1b, a method of manufacturing an LCD device, which comprises vacuum injecting liquid crystals 5 through a previously provided liquid crystal inlet 6 into a container formed by disposing two electrode substrates 2 to face each other so that the surface of each electrode substrate having an alignment film 1 (mainly made of polyimide) attached thereto faces inwards, compressing the two electrode substrates 2 at a predetermined interval determined by spacers 3 and curing a heat curable type epoxy based sealing material 4 to bond and hold the electrode substrates, and closing the liquid crystal inlet 6 using a closing material including a heat curable type epoxy resin or a UV curable type acryl resin so that the liquid crystals 5 do not leak out.

(2) A method of manufacturing an LCD device, which is performed

in the same manner as in the method (1), with the exception that a UV curable type epoxy resin or UV curable type acryl resin is used as the sealing material 4, and a UV curable type acryl resin is used as the closing material 7.

(3) As shown in FIGS. 2a to 2d, a method of manufacturing an LCD device, comprising applying a sealing material 10 on at least one surface of two facing electrode substrates 8 and 9 each having an alignment film attached thereto, adding a predetermined amount of liquid crystals 12 in droplets onto the electrode substrate 8, and bonding the two electrode substrates 8 and 9 in a vacuum.

(4) As shown in FIGS. 3a to 3e, a method of manufacturing an LCD device, comprising applying a sealing material 16 on at least one surface having a previously provided liquid crystal outlet 15 of two facing electrode substrates 13 and 14 each having an alignment film attached thereto, adding excess liquid crystals 18 in droplets onto the electrode substrate 13, bonding the two electrode substrates in a vacuum, and discharging the excess liquid crystals, and closing the liquid crystal outlet 15 using a closing material 19.

[Problems to be Solved by the Invention]

However, the methods (1) and (2) are disadvantageous in that because the inlet contacts the liquid crystals, liquid crystals may be contaminated or impurities may be introduced, and thus, display panels may be faulty. Further, a long time period is required to inject the liquid crystals.

In addition, although the methods (3) and (4) disclosed in Japanese Patent Laid-open Publication No. Sho. 62-89025 and Japanese Patent Laid-open Publication No. Hei. 6-235925 solve the problems of the methods (1) and (2), the sealing material is not mentioned in the above patents. As the sealing material, a UV curable type resin is more effectively used than is a heat curable type resin, in view of the productivity of LCD devices, alignment of two substrates, and improvement of non-uniform gaps.

However, even if any sealing material is used, if the viscosity at 25°C of the sealing material is too low, the sealing material flows toward the liquid crystals, so a desired display screen is not obtained. Meanwhile, if the viscosity at 25°C of the sealing material is too high, the gap is insufficiently formed. When a UV curable type resin is used as a

sealing material, the alignment film on the electrode substrate in the LCD device which is exposed to UV upon curing may be damaged and thus alignment properties of the liquid crystals may be worsened.

To solve the above problems, an object of the present invention is to provide a novel and highly reliable LCD device, which is advantageous because it may be manufactured by injecting the liquid crystals for a relatively short time while two electrode substrates are almost accurately aligned, with the formation of a uniform gap therebetween, the liquid crystals are not contaminated and impurities are not introduced, a display screen is excellent, gap formation is sufficient, and the alignment film on the electrode substrate is not damaged, thus exhibiting good alignment properties of the liquid crystals.

Another object of the present invention is to provide a method of manufacturing such an LCD device.

[Means for Solving the Problem]

To achieve the above objects, the present inventors have found that, as in the method (3) shown in FIGS. 2a to 2d, when two electrode substrates 8 and 9, each having an alignment film attached thereto, are

bonded in a vacuum after applying the sealing material 10 on at least one surface of the two electrode substrates 8 and 9 and adding the predetermined amount of liquid crystals 12 in droplets onto the electrode substrate 8, a radical polymerizable type acryl based light curable resin composition and/or ene/thiol based light curable resin composition, having a viscosity at 25°C ranging from 40 to 100 Pa·s, may be used as the sealing material 10, and light having a wavelength from 350 to 780 nm is radiated, or UV rays, wavelengths of which are not controlled, are radiated while the surface of the alignment film is shielded from light using a masking member, thus curing the sealing material to bond the electrode substrates, to manufacture a desired LCD device, thereby completing the present invention.

To increase the adhesive strength between the electrode substrates 8 and 9 each having an alignment film attached thereto, the above composition serving as the sealing material 10 may further include an adhesion accelerator.

As a light source used in the present invention, a mercury lamp, a xenon lamp, a metal halide lamp, etc., is usefully used, each of which generates a large amount of visible light and UV rays having wavelengths

of 780 nm or less. However, light generated from such a light source may excessively heat the LCD device, or may deteriorate the liquid crystals.

When light curing the above composition, light must contact only the composition. The radiation time ranges from 0.1 to 5 min. If the radiation time is shorter than 0.1 min, adhesive strength is weak due to insufficient light curing. On the other hand, if the time is longer than 5 min, productivity is decreased and a useful LCD device is not obtained.

As such, the alignment film may be damaged due to light having wavelengths less than 350 nm being generated from the light source, whereas the curing reaction may be retarded due to light having wavelengths more than 780 nm, thus decreasing the productivity. Hence, light ranging from 350 to 780 nm is preferably used.

Upon radiation, UV rays are radiated through a cut-off filter (to block light having wavelengths less than 350 nm). In addition, the surface of the alignment film on the electrode substrate is shielded from light using a masking member, such as a blackened metal sheet, thus curing the composition. When the two facing electrode substrates each having an alignment film attached thereto are bonded and held, UV rays

may be directly radiated thereon, without the use of a cut-off filter.

In addition, an LCD device may be manufactured by applying a sealing material on at least one surface of the two facing electrode substrates each having an alignment film attached thereto and further including a thin film transistor (TFT) and a color filter provided thereon and a transparent conducting film provided therebelow, distributing and holding spacers on any one electrode substrate, adding a necessary amount of liquid crystals in droplets onto the substrate on which the sealing material is applied, and bonding the two electrode substrates in a vacuum.

Used as the sealing material in the present invention, a radical polymerizable type acryl based light curable resin composition, which has a viscosity at 25°C ranging from 40 to 100 Pa·s, includes a (meth)acryl based resin and a photosensitizer. In addition, for improvement in properties, an adhesion accelerator (silane based coupling agent), a filler, etc., may be further included, if required.

If the sealing material has a viscosity at 25°C less than 40 Pa·s, it flows toward the liquid crystals, not obtaining a desired display screen. Meanwhile, if the sealing material has a viscosity at 25°C more than 100

Pa·s, the gap between the substrates is insufficiently formed, and thus, the display screen is non-uniform. Thus, the viscosity at 25°C is preferably in the range from 40 to 100 Pa·s (a viscosity at 25°C of liquid crystals is in the range from 0.001 to 0.1 Pa·s).

The (meth)acryl based resin includes one or more (meth)acryl groups in one molecule, and is not particularly limited as long as it may be rapidly cured by radical polymerization.

Further, to increase moistureproofness, adhesive strength and incompatibility with liquid crystals, a molecular backbone of (meth)acryl based resin is preferably formed of polyester, polyether, hydrocarbons, silicone, etc.

The (meth)acryl based resin includes materials having (meth)acryl groups at both terminal portions of the molecular backbone, for example, di(meth)acrylate, hexanediol(meth)acrylate, ethyleneglycol(meth)acrylate, or butanediol(meth)acrylate of polyester, polyethyleneglycol, bisphenol A diglycidylether, poly-1,2-butadiene, or polydimethylsiloxane, producible from ethyleneglycol and adipic acid.

To decrease the viscosity and control a glass transition temperature, a (meth)acryl compound having one (meth)acryl group in

one molecule may be used, which is exemplified by 2-ethylhexyl(meth)acrylate, 2-hydroxy propyl(meth)acrylate, lauryl(meth)acrylate, decyl(meth)acrylate, benzyl(meth) acrylate, etc. In addition, to increase the adhesive strength, 2-hydroxyethyl(meth)acrylate may be used.

The photosensitizer used in the present invention is not particularly limited as long as it may cause light decomposition or dehydrogenation using light having a wavelength ranging from visible light to UV rays and also may produce a radical to initiate radical polymerization by a (meth)acryl group.

The photosensitizer includes, for example, benzoinethers such as benzoinisopropylether, acetophenones such as 2,2-diethoxyacetophenone, benzophenones such as 1-hydroxycyclohexylphenylketone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, benzoin or p-methoxybenzophenone, xantones such as thioxantone, anthraquinones such as m-chloroacetophenone, propiophenone, benzyl or 2-methylanthraquinone, or benzyldimethylketals.

The photosensitizer is used in an amount of 0.01 to 5 parts by weight, on the basis of 100 parts by weight of a (meth)acryl based resin.

If the amount is less than 0.01 parts by weight, light curability of the acryl based resin composition is decreased. Meanwhile, if the amount exceeds 5 parts by weight, adhesive strength is weakened.

The adhesion accelerator used to increase the adhesive properties of the resin composition of the present invention includes, for example, a silane based coupling agent, a titanium based coupling agent, polychloroprene, poly-1,4-butadiene, styrene-butadiene copolymer, acrylonitrile-styrene-butadiene terpolymer, or graft copolymer of rubbers such as ethylene propylene based rubber and (meth)acryl based resin. The adhesion accelerator is used in an amount of 0.1 to 10 parts by weight, on the basis of 100 parts by weight of a (meth)acryl based resin. If the amount is less than 0.1 parts by weight, effects on the acceleration of the adhesive strength are insufficiently exhibited. Meanwhile, if the amount exceeds 10 parts by weight, excess adhesion accelerator in the acryl based composition flows over the liquid crystal layer and thus negatively affects the alignment properties of liquid crystals while decreasing the glass transition temperature.

The filler, which is used to increase the applicability of the resin composition of the present invention and control the viscosity of the

composition or the heat expansion coefficient of the curing material while preventing the dissolution of the composition in liquid crystals, includes silica, alumina, calcium carbonate, etc. The filler is used in an amount of 5 to 100 parts by weight, on the basis of 100 parts by weight of a (meth)acryl based resin, so that the viscosity at 25°C of the sealing material is in the range from 40 to 100 Pa·s. If the amount is less than 5 parts by weight, insignificant effects are obtained. Meanwhile, if the amount exceeds 100 parts by weight, the adhesive strength of the acryl based resin composition is weakened.

In addition, the ene/thiol based light curable resin composition used in the present invention includes a polyene compound, a polythiol compound, and a photosensitizer, and may further include an adhesion accelerator (silane based coupling agent), a filler, etc., if required.

The polyene compound includes at least two unsaturated double bonds (C=C) in one molecule, and the polythiol compound includes at least two mercapto groups (-SH) in one molecule. The polyene compound or polythiol compound is not particularly limited as long as it may be rapidly cured by radical polymerization. The polyene compound is selected from the group consisting of divinylbenzene, divinyltoluene,

triallylcyanurate, triallylisocyanurate, tetraallyloxyethane, trimethylolpropane diallylether, trimethylolpropane triallylether, pentaerythritol diallylether, pentaerythritol triallylether, pentaerythritol tetraallylether, ethyleneglycol (meth)allylether, propyleneglycol (meth)allylether, butyleneglycol (meth)allylether, polyethyleneglycol (meth)allylether, polypropyleneglycol di(meth)allylether, polybutyleneglycol di(meth)allylether, di(meth)allylether of glycol as a block or random copolymer of ethyleneoxide and propyleneoxide, di(meth)allylether of glycol as a block or random copolymer of ethyleneoxide and tetrahydrofuran, di(meth)allylether of bisphenol A, di(meth)allylether of (poly)ethylene oxide modified bisphenol A, di(meth)allylether of (poly)propylene oxide modified bisphenol A, and combinations thereof, but is not limited thereto.

The polythiol compound is selected from the group consisting of diglycol dimercaptane, triglycol dimercaptane, tetraglycol dimercaptane, thiodiglycol dimercaptane, thiotriglycol dimercaptane, thiotetraglycol dimercaptane, polythiol compounds obtained by reacting a mercapto group of excess polythiol compound with an epoxy group of the following polyepoxide compound, and combinations thereof, but is not

limited thereto.

The polyepoxide compound is selected from the group consisting of bisphenol A type epoxide, ethyleneglycol diglycidylether, polyethyleneglycol diglycidylether, propyleneglycol diglycidylether, polypropyleneglycol diglycidylether, neopentylglycol diglycidylether, 1,6-hexanediol diglycidylether, glycerol diglycidylether, glycerol triglycidylether, trimethylolpropane diglycidylether, trimethylolpropane triglycidylether, diglycerol polyglycidylether, bisphenol S type epoxide, bisphenol F type epoxide, hydrogenated bisphenol A type epoxide, and combinations thereof, but is not limited thereto.

A mixing ratio of the polyene compound and the polythiol compound used in the composition of the present invention is determined as a molar ratio of carbon-carbon unsaturated double bond of polyene and a mercapto group of polythiol, and ranges from 1:1.5 to 1.5:1, preferably from 1:1.2 to 1.2:1, and more preferably, is about 1:1. If the mixing ratio of the polyene compound and the polythiol compound falls out of the above range, offensive odors may occur after curing, or the curing reaction may not take place due to insufficient hardness of the curing material. The photosensitizer used in the ene/thiol based light

curable resin composition of the present invention includes those used in the acryl based light curable resin composition, and is used in an amount of 0.01 to 5 parts by weight, on the basis of a total of 100 parts by weight of the polyene compound and polythiol compound. If the amount is less than 0.01 parts by weight, light curability of the ene/thiol based light curable resin composition is decreased. Meanwhile, if the amount exceeds 5 parts by weight, adhesive strength is weakened.

The adhesion accelerator, which functions to increase the adhesive properties of the resin composition of the present invention, includes those used in the acryl based light curable resin composition, and is exemplified by a silane based coupling agent, a titanium based coupling agent, polychloroprene, poly-1,4-butadiene, styrene-butadiene copolymer, acrylonitrile-styrene-butadiene terpolymer, or graft copolymer of rubbers such as ethylene propylene based rubber and (meth)acryl based resin. The adhesion accelerator is used in an amount of 0.1 to 10 parts by weight, on the basis of a total of 100 parts by weight of the polyene compound and polythiol compound. If the amount is less than 0.1 parts by weight, effects on the acceleration of the adhesive strength are insufficiently exhibited. Meanwhile, if the amount exceeds

10 parts by weight, excess adhesion accelerator in the ene/thiol based resin composition flows over the liquid crystal layer and thus negatively affects the alignment properties of the liquid crystals while decreasing the glass transition temperature.

The filler, which is used to increase the applicability of the resin composition and control the viscosity of the composition or the heat expansion coefficient of the curing material while preventing the dissolution of the composition in liquid crystals, includes those used in the acryl based light curable resin composition, and is exemplified by silica, alumina, calcium carbonate, etc. The filler is used in an amount of 5 to 100 parts by weight, on the basis of a total of 100 parts by weight of the polyene compound and polythiol compound, so that the viscosity at 25°C of the sealing material is in the range from 40 to 100 Pa·s. If the amount is less than 5 parts by weight, insignificant effects are exhibited. Meanwhile, if the amount exceeds 100 parts by weight, adhesive strength of the ene/thiol based resin composition is weakened.

The resin composition of the present invention may further include a defoamer, a leveling agent, a polymerization inhibitor, etc., if required.

Hereinafter, a method of manufacturing an LCD device using the

resin composition of the present invention is described. On the surface of the alignment film of either electrode substrate of two facing electrode substrates, each having an alignment film attached thereto, the sealing material, which is the resin composition of the present invention, is applied in the form of a rectangular pattern. The application process is performed using screen printing, and may be conducted using a dispenser.

Onto the central portion of the rectangular pattern of the substrate, having the sealing material applied thereon, a predetermined amount of liquid crystals is added in droplets.

The two substrates are aligned to be spaced apart from each other by the spacers distributed therebetween in a vacuum so as to face each other while the alignment films formed thereon are positioned inwards. Then, the gap between the substrates is controlled at a desired interval, under atmospheric pressure.

Subsequently, after the position alignment and the gap formation, light having a predetermined wavelength (350-780 nm) is radiated onto the resin composition, or UV rays are radiated onto the resin composition while only the surface of the alignment film is shielded from

light using a masking member, thus curing the resin composition to bond the two substrates, to manufacture a desired LCD device.

[Embodiment of the Invention]

A better understanding of the present invention may be obtained in light of the following examples which are set forth to illustrate, but are not to be construed to limit the present invention.

As a sealing material used to bond two electrode substrates each having an alignment film attached thereto, the kinds of a light curable resin composition and composition number are shown in Table 2 below.

Table 2

Composition No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(Meth) Acryl Based Resin	Poly1,2-Butadiene Dimethacrylate (mw 2000)	59	-	-	-	-	-	-	-	-	-	-	-	-	59	-
	Bisphenol A Diglycidylether Diacrylate	-	19	10	10	15	40	-	-	-	-	-	-	10	-	10
	Ethyleneglycol Dimethacrylate	41	81	-	-	60	40	-	-	-	-	-	-	-	41	-
	Butanediol Diacrylate	-	-	90	76	-	-	-	-	-	-	-	-	90	-	90
	Lauryl Methacrylate	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-
	Benzyl Methacrylate	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-
	2-Hydroxyethyl Methacrylate	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
Polye	Bisphenol A Diallylether	-	-	-	-	-	-	24			57	-	-	-	-	-

ne	Diallylether of Glycol as Random Copolymer of Ethyleneoxide and Tetrahydrofuran	-	-	-	-	-	-	-	50	-	-	81	-	-	-	-
	Triallyl Isocyanaurate	-	-	-	-	-				25			51	-	-	-
Polythiol	Polythiol as Reaction Product of Bisphenol A Epoxide and excess Triglycol Dimercaptane	-	-	-	-	-		76	50	75	-	-	-	-	-	
	Tetraglycol Dimercaptane	-	-	-	-	-	-	-	-	-	43	19	49	-	-	-
Others	Benzoin Isopropylether (Photosensitizer)	3	2	1	1	1	2	1	1	1	1	1	1	1	3	1
	γ-Methacryloxy Propyltrimethoxy Silane (Adhesion Accelerator)	1	1	-	-	-	-	1	-	-	1	-	-	-	1	-
	Use of Silica (Filler)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Viscosity at 25°C (Pa·s)		$40 \leq$ viscosity ≤ 100												<40	>100	<40

*) Composition is shown as a weight ratio.

As shown in Table 2, composition Nos. 1 to 6 are acryl based radical polymerizable type light curable resin compositions, and composition Nos. 7 to 12 are ene/thiol based radical polymerizable type light curable resin compositions. Although composition Nos. 13 to 15 are acryl based radical polymerizable light curable resin compositions, their viscosities at 25°C fall out of the range of the present invention. The viscosities were measured using a viscometer.

The resin composition (sealing material) was applied in a

rectangular pattern on an electrode substrate 8 having an alignment film attached thereto, using a dispenser, as shown in FIG. 2. Onto the central portion of the pattern, a necessary amount of liquid crystals 12 was added in droplets. On the screen area of the other electrode substrate 9 having an alignment film attached thereto, bead-shaped spacers 11 having a diameter of 6.5 μm were distributed.

The two electrode substrates were aligned to be spaced apart from each other by the spacers disposed therebetween in a vacuum so as to face each other and so that the alignment films formed thereon were positioned inwards, after which the gap between the substrates was controlled at a desired interval under atmospheric pressure.

Subsequently, according to the method of the present invention, as shown in FIGS. 4 and 5, light was radiated onto the sealing material 22 or 29 under predetermined conditions after the position alignment and gap formation, thus curing the sealing material 22 or 29.

As seen in FIG. 4, as a cut-off filter 25 to block light having wavelengths less than 350 nm, a color glass filter UV-35 (available from Toshiba Glass Co. Ltd., Japan) was used, whereby light was limitedly radiated from a light source 26, such as a high pressure mercury lamp,

onto the resin composition, thus light curing the resin composition. In addition, as in FIG. 5, where R > 5, using an about 2 mm thick blackened metal aluminum sheet as a masking member 32, the surface of the alignment film was shielded from light, whereby light was unlimitedly radiated from a light source 33, such as a high pressure mercury lamp, thus light curing the resin composition.

Whether the LCD device 35 thus obtained realized a good display screen was observed with the naked eye.

Thereafter, the alignment properties of the polyimide based alignment film 34 of the LCD device 35 were measured, as shown in FIG. 6.

That is, polarizing directions of two polarizing substrates 39 were set perpendicular to each other, and the LCD device 35 was interposed between the above two substrates so that one substrate of the LCD device was positioned to face toward the light 40 and the other substrate thereof was observed with the naked eye 41.

As the result, when the alignment was regular and light was uniformly observed, the alignment film 34 of the LCD device 35 was assumed not to be damaged, thus realizing good alignment properties.

However, when light was non-uniformly observed, the alignment film 34 was assumed to be damaged, thus having worsened alignment properties. In addition, adhesive strength was measured. Whether the sealing material had peeled off was observed with the naked eye. The adhesive strength of the LCD device that had not peeled was judged to be good, while the adhesive strength of the LCD device that had peeled was judged to be bad.

To assay the alignment properties and the adhesive strength of the LCD device after being initially measured, a reliability test was conducted by allowing the LCD device to stand at a high temperature (60°C, 1000 hr) and also at a high temperature under high humidity (70°C, 95%RH, 500 hr).

Using the light curable resin compositions (sealing materials) shown in Table 2, the above properties of the LCD device were measured by varying the curing conditions. The results are given in Table 3, below.

Table 3

No.		Example						Comparative Example								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Curing	Resin Com.No.	1-6	7-12	1-6	7-12	1-6	7-12	1-6	7-12	1-6	7-12	1-6	7-12	13	14	15

Cond.	Use of Cut-off Filter		Yes	Yes	-	-	Yes	Yes	No	No	-	-	No	No	Yes	Yes	Yes
	Presence of Masking Member		-	-	Yes	Yes	-	-	-	-	No	No	-	-	-	-	-
	Light Radiat. Condi. *	100 mW/cm^2 x90s	→	-	→	-	-	-	→	-	→	-	-	-	→	→	→
		100 mW/cm^2 x50s	-	→	-	→	-	-	-	→	-	→	-	-	-	-	-
		100 mW/cm^2 x30s	-	-	-	-	→	→	-	-	-	-	→	→	-	-	-
Prop. **	Display Screen		o	o	o	o	o	o	o	o	o	o	o	o	X	X	X
	Alignment	Initial	o	o	o	o	o	o	X	X	X	X	X	X	o	o	o
		High Temp. (60°C, 1000h)	o	o	o	o	o	o	X	X	X	X	X	X	o	o	o
		High Temp., High Humidity (70°C, 95%, 500h)	o	o	o	o	o	o	X	X	X	X	X	X	o	o	o
	Adhesive Strength	Initial	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		High Temp. (60°C, 1000h)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		High Temp., High Humidity (70°C, 95%, 500h)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

*) Light radiation condition depends on a wavelength of 365 nm, and 's' is second. '→' means the use of light radiation condition

**) 'RH' is relative humidity, 'h' is hour. 'o ' is good, and 'X' is poor.

As is apparent from Table 3, Example No. 1 shows six kinds of LCD device manufactured by applying each of resin composition Nos. 1 to 6 of Table 2, under radiation conditions of 100 mW/cm^2 (wavelength 365 nm) x 90 sec using a cut-off filter. In Table 3, the properties of Examples

represented by ○ mean that all properties of six kinds of LCD device are good.

As in Table 3, since the resin compositions of Example Nos. 1 to 6 had viscosity at 25°C that satisfied the viscosity range of the present invention before being light cured, the LCD devices realized excellent display screens. Also, by using the cut-off filter or masking member upon curing, the alignment properties and adhesive strength of the LCD devices were confirmed to be initially good and also to be good even after the reliability test, regardless of radiation conditions.

On the other hand, the resin compositions of Comparative Example Nos. 7 to 12 had viscosity at 25°C that satisfied the viscosity range of the present invention before being light cured, and therefore, the LCD devices realized excellent display screens. However, without the use of the cut-off filter or masking member upon curing, the alignment properties of the LCD devices were initially bad although the adhesive strength thereof was good.

Further, in Comparative Example Nos. 13 to 15, the cut-off filter was used upon light curing, and thus, the alignment properties and adhesive strength of the LCD devices were confirmed to be initially good and also to

be good even after the reliability test. However, since their resin compositions had viscosities at 25°C that fell out of the viscosity range of the present invention before being light cured, the LCD devices realized poor display screens.

In Table 3, all properties of the LCD devices of Example Nos. 1 to 6 were confirmed to be initially good and also to be good even after the reliability test.

Although the gap accuracy and the position accuracy of the LCD devices were (6.5 ± 0.5) μm and 6.0 μm, respectively, according to the method shown in FIG. 1 (conventional method) using a heat curable type epoxy based sealing material, they were (6.5 ± 0.2) μm and 2.0 μm according to the method of the present invention (Ex. Nos. 1 to 6 in Table 3). From this, the accuracy was confirmed to increase.

The LCD device, which comprises two electrode substrates, respectively including a TFT and a color filter provided thereon, both including a transparent conducting film provided therebelow, and being disposed to face each other such that an alignment film of each electrode substrate is positioned inwards, can be manufactured by radiating light onto the transparent conducting film according to the method of the

present invention (Ex. Nos. 1 to 6 in Table 3).

[Effect of the Invention]

As described hereinbefore, the present invention provides an LCD device and a method of manufacturing the same, solving conventional problems. The LCD device of the present invention can be manufactured by injecting the liquid crystals for a relatively short time while two electrode substrates are almost accurately aligned, with the formation of a uniform gap therebetween, no contamination of liquid crystals or introduction of impurities, excellent display screen and sufficient gap formation, and no damage to the alignment film on the electrode substrate. Thus, the LCD device has well-aligned liquid crystals, and can be less expensively manufactured while realizing high reliability.

[Description of Drawings]

FIGS. 1a and 1b are schematic views showing a conventional process of manufacturing an LCD device;

FIGS. 2a to 2d are schematic views showing another conventional process of manufacturing an LCD device;

FIGS. 3a to 3e are schematic views showing a further process of manufacturing an LCD device;

FIG. 4 is a view showing a process of curing the resin composition of the present invention;

FIG. 5 is a view showing another process of curing the resin composition of the present invention; and

FIG. 6 is a view showing a process of measuring the alignment properties of the LCD device of the present invention.

(Description of the Reference Numerals in the Drawings)

1, 20, 27, 34: alignment film

2, 8, 9, 13, 14: electrode substrate having alignment film attached thereto

3, 11, 17, 23, 30, 37: spacer

4: heat curable type epoxy based sealing material

5, 12, 18, 24, 31, 38: liquid crystal

6: liquid crystal inlet

7, 19: closing material

10, 16, 22, 29, 36: sealing material

15: liquid crystal outlet

21, 28, 35: liquid crystal display device

25: cut-off filter

26, 33: light source

32: masking member

39: polarizing substrate (two)

40: light (visible light, etc.)

41: eye